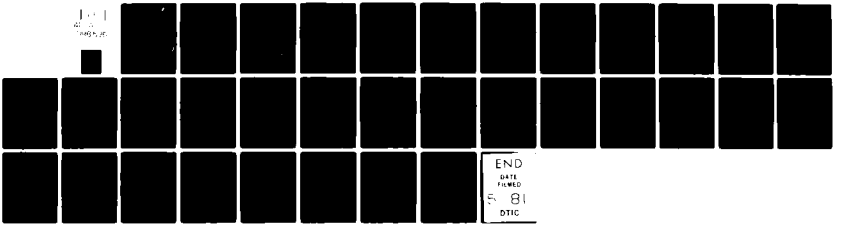
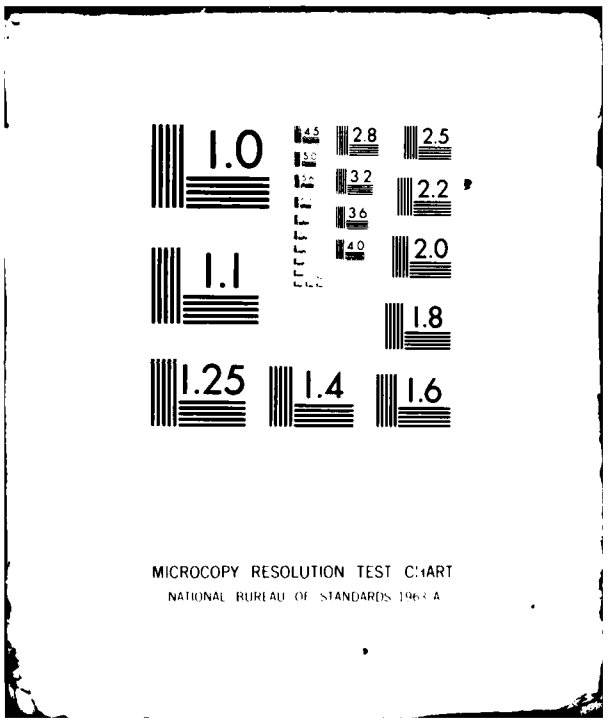
AD-A098 595 AVCO SYSTEMS DIV WILMINGTON MA F/G 16/3
MM III/MK 12A REENTRY VEHICLE CARBON/CARBON NOSETIP PRODUCTION --ETC(U)
MAY 80 F04704-80-C-0011
UNCLASSIFIED AVSD-0114-80-CR NL

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AVCO SYSTEMS DIVISION
201 LOWELL STREET, WILMINGTON, MASSACHUSETTS 01887

JUN 3 1980

LEVEL II

28 May 1980
S300-DJM-80-118

Department of the Air Force
Ballistic Missile Office
Norton Air Force Base
San Bernardino, CA 92409

Attention: Captain K. Schoonover/MNBR

Gentlemen:

Subject: Transmittal of Avco Document AVSD-0114-80-CR, Critical Item Control Plan, MMIII/MK12A Reentry Vehicle, Carbon/Carbon Nosetip Production, dated 28 May 1980.
Contract F04704-80-C-0011

Reference: A. Subject Contract, Attachment 1, Task 4.2.2.3
B. CDRL Sequence Number 042A2
C. BMO/MNCA-1 Letter Dated 27 May 1980

The subject document is transmitted in accordance with Reference A and in compliance with Reference B, as approved by Reference C.

Very truly yours,

D. J. McQueen
Program Manager

Enclosure: Subject Document

cc: AVCO/SD, Attention: Mr. D. J. Sullivan, Contracts Administration (ltr. only)
BMO/MNCA-1, Attention: Mr. C. Howard Kirk (letter only)

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MM III/MK 12A REENTRY VEHICLE

CARBON/CARBON NOSETIP PRODUCTION PROGRAM.

(12) 33

(9)

CRITICAL ITEM CONTROL PLAN.

(15) CONTRACT F04704-80-C-0011
CDRL ITEM 042A2

(14) AVSD-0114-80-CR

(11) 28 MAY 1980

AVCO CORPORATION
AVCO SYSTEMS DIVISION
201 Lowell Street
Wilmington, Massachusetts 01887

Prepared for

DEPARTMENT OF THE AIR FORCE
BALLISTIC MISSILE OFFICE
Norton Air Force Base, California 92409

407742

MM III/MK 12A REENTRY VEHICLE

CARBON/CARBON NOSETIP PRODUCTION PROGRAM

CRITICAL ITEM CONTROL PLAN

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide SAMSO with Avco's current plan for critical item control and subsequent monitoring of the manufacturing processes in production of the Mark 12A Carbon/Carbon nosetip.

1.2 DEFINITION

MIL-STD-1543, Reliability Program Requirements for Space and Missile Systems, defines a "critical item" as one which meets any of a number of criteria specified therein. Several of these criteria are applicable to the Mark 12A. Nosetip Program:

> "A failure of the item would critically affect system operation or cause the system to not achieve specified objectives."
>
> "The item is a single-point failure."
>
> "The item is difficult to procure and/or manufacture relative to state-of-the-art techniques."

1.2 DEFINITION (Cont'd)

The Critical Item of this program is the end-item; the Nosetip, Carbon/Carbon, Part No. 7731107-1. It is bonded assembly comprised of three components:

a. Shell, Nose, Forward Section, P/N 7731108-1. Machined 7075-T73 aluminum. This element has the attaching threads for the nosetip assembly. Manufactured at Avco/SD.

b. Shield, Nose, P/N 7731109-1. A 2-D Carbon/Phenolic fairing between the nosetip billet and the reentry vehicle. Purchased by Avco from Haveg Industries, Santa Fe Springs, California.

c. Nosetip, P/N 7731110-1, 3-D Carbon/Carbon machined billet. Manufactured by Avco and sent to General Electric Company, Reentry Systems Division (RESD), Philadelphia, PA for densification process. Returned to Avco for assembly into end-item and final machining.

1.3 SCOPE

This document has been prepared in compliance with the requirements of Data Item Description DI-R-30511 and is submitted in accordance with CDRL Item 042A2. It identifies the organizations and personnel responsible for managing and implementing critical item control at Avco and General Electric Company/RESD; it provides an expanded Critical Items Matrix (Table 1) covering all three components of the final assembly.

a.	Nosetip, Carbon/Carbon	Nosetip Assy	Nosetip	Nose Shield	Nose Shell
b.	7731107	7731114	7731110	7731109	7731108
c.	Avco/SD	Avco/SD	Avco/GE	Haveg Ind.	Avco/SD
d.	Configuration Item	←			→
e.	Single Point Failure	← Difficult Critical Processes →			

a. Description

b. Drawing Number

c. Manufacturer(s)

d. Configuration Item in which Critical Item is incorporated

e. Characteristics that make the Item Critical

Table 1: CRITICAL ITEMS MATRIX (Ref. Item 3, DI-R-3051)

1.3 SCOPE (Cont'd)

Manufacturing services performed by Haveg Industries and General Electric/RESD are previously qualified processes for which tight controls have been developed and documented as indicated in Table 2 and these processes will continue to be monitored by these suppliers and the AVCO Quality Assurance departments. The existing controls and processes are adequately documented, therefore, Subcontractor Critical Item Control Plans will not be required from these suppliers.

1.4 CONTRACTOR & SUBCONTRACTOR ORGANIZATIONS

Avco Systems Division was awarded the MK 12A Carbon/Carbon Nosetip contract on the basis of its proven technological and production capability in Fine-Weave Pierced Fabric (FWPF) Carbon/Carbon Nosetips. Avco in turn has awarded the subcontract for the densification, or high-pressure impregnation/carbonization (HiPIC) of the processing billets to General Electric Company/Reentry Systems Division, Philadelphia, PA, based on its prior qualification and extensive experience in applying this process.

The personnel responsible for control of the Carbon/Carbon Nosetip production are the program office organizations at Avco Systems Division, and at GE/RESD. Overall responsibility for the Carbon/Carbon Nosetip Program at Avco is held by Mr. D. J. McQueen.

1.5 CRITICAL ITEM DETERMINATION (Reference Item 2, DI-R-30511)

In determination of the Critical Item of the MK 12A Carbon/Carbon Nosetip Program, the criteria of MIL-STD-1543 were reviewed. Applicable descriptions selected were:

a) "A failure of the item would critically affect system operation or cause the system to not achieve specified objectives,"

b) "The item is a single-point failure,"

c) "The item is difficult to procure and/or manufacture..."

The end-item (Nosetip, Carbon/Carbon, P/N 7731107-1) meets the above criteria as well as some of the subassembly processes such as the 3-D Fine-Weave Pierced Fabric Preform, the Nose Shield (P/N 7731109-1) and the impregnation services of GE/RESD. These processes are performed using qualified manufacturing processes of components developed and flight-tested on previous SAMSO programs.

The selected manufacturers (Avco Manufacturing Department, Haveg Industries and GE/RESD) were chosen for the reason stated above and through competitive bidding.

Procurement of components/subassemblies at Avco is done in accordance with Avco/Systems Division Policy and Procedures Manual, Section 5-8, Make or Buy Policy and Procedures.

The MK 12A Carbon/Carbon Nosetip is a previously qualified component of the Minuteman III, Mark 12 Reentry Vehicle Program.

2.0 PRODUCTION CONTROL

2.1 PRODUCTION MANAGEMENT

The fabrication and assembly of the Mark 12A nosetips will be monitored and controlled by Avco's proven management techniques and based on a system which complies with MIL-STD-1528. Manufacturing management is directly responsible for this system and for assuring accomplishment of:

a) Production feasibility assessment.

b) Design and production engineering for producibility.

c) Production planning.

d) Verification of production readiness.

e) Development and application of manufacturing methods.

f) Surveillance of production operations.

The Producibility Engineering Section of the Manufacturing Engineering Department has been assigned responsibility for Mark 12A carbon-carbon nosetip manufacturing planning and is applying engineering design and analysis techniques to the planning and effective utilization of resources to ensure a quality nosetip on schedule and at minimum cost.

Figures 2.1-1 and 2.1-2 describe the functions of Avco's Production Management system. These functions are further detailed in Avco's Developmental Operating Manual, Avco Systems Division Policies and Procedures (Volumes 1 and 2), and Avco's Material and Engineering Control Manual. Figure 2.1-3 shows the details of our manufacturing documentation flow.

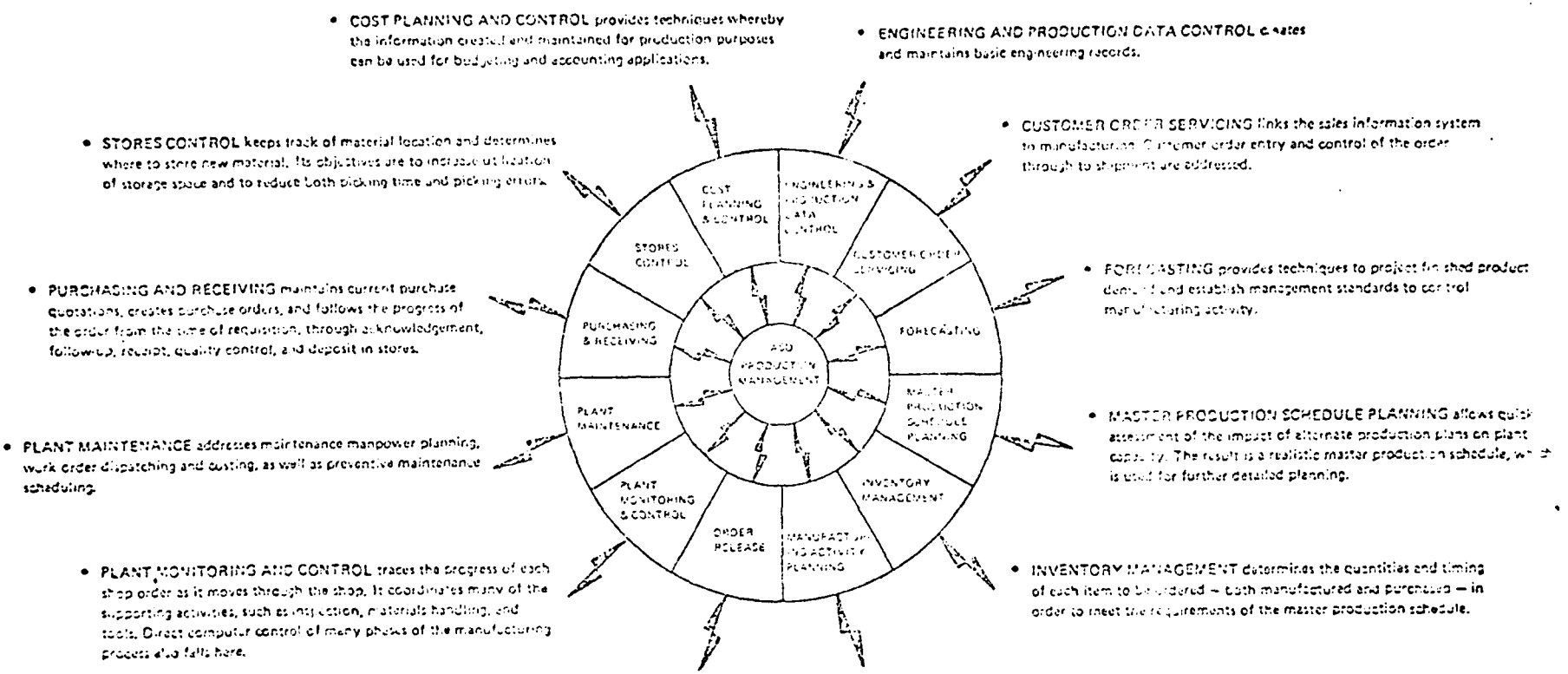


Figure 2.1-1 AVCO SYSTEMS DIVISION PRODUCTION MANAGEMENT

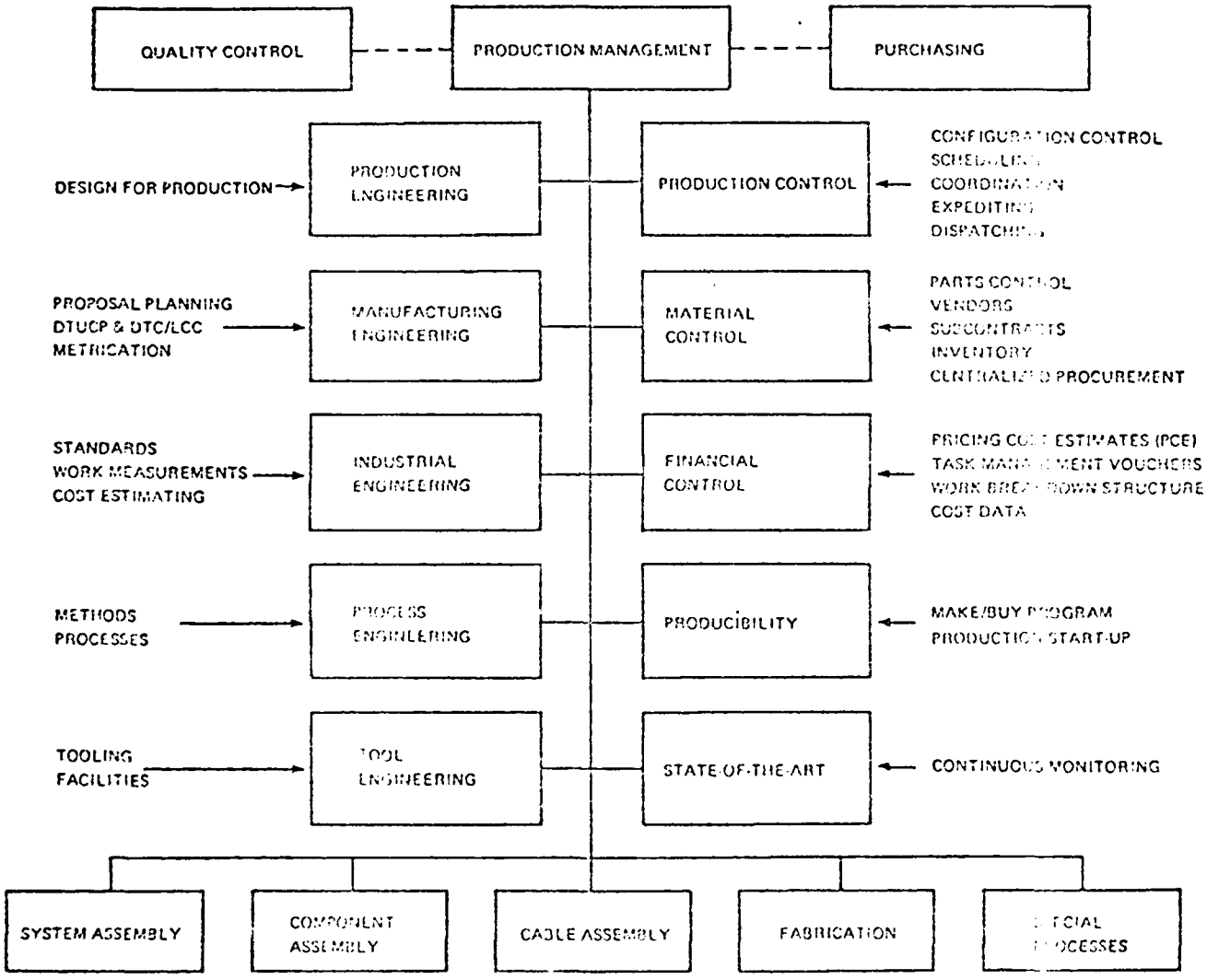


FIGURE 2.1-2. AVCO SYSTEMS DIVISION PRODUCTION MANAGEMENT; MIL-STD-1528 FUNCTIONS

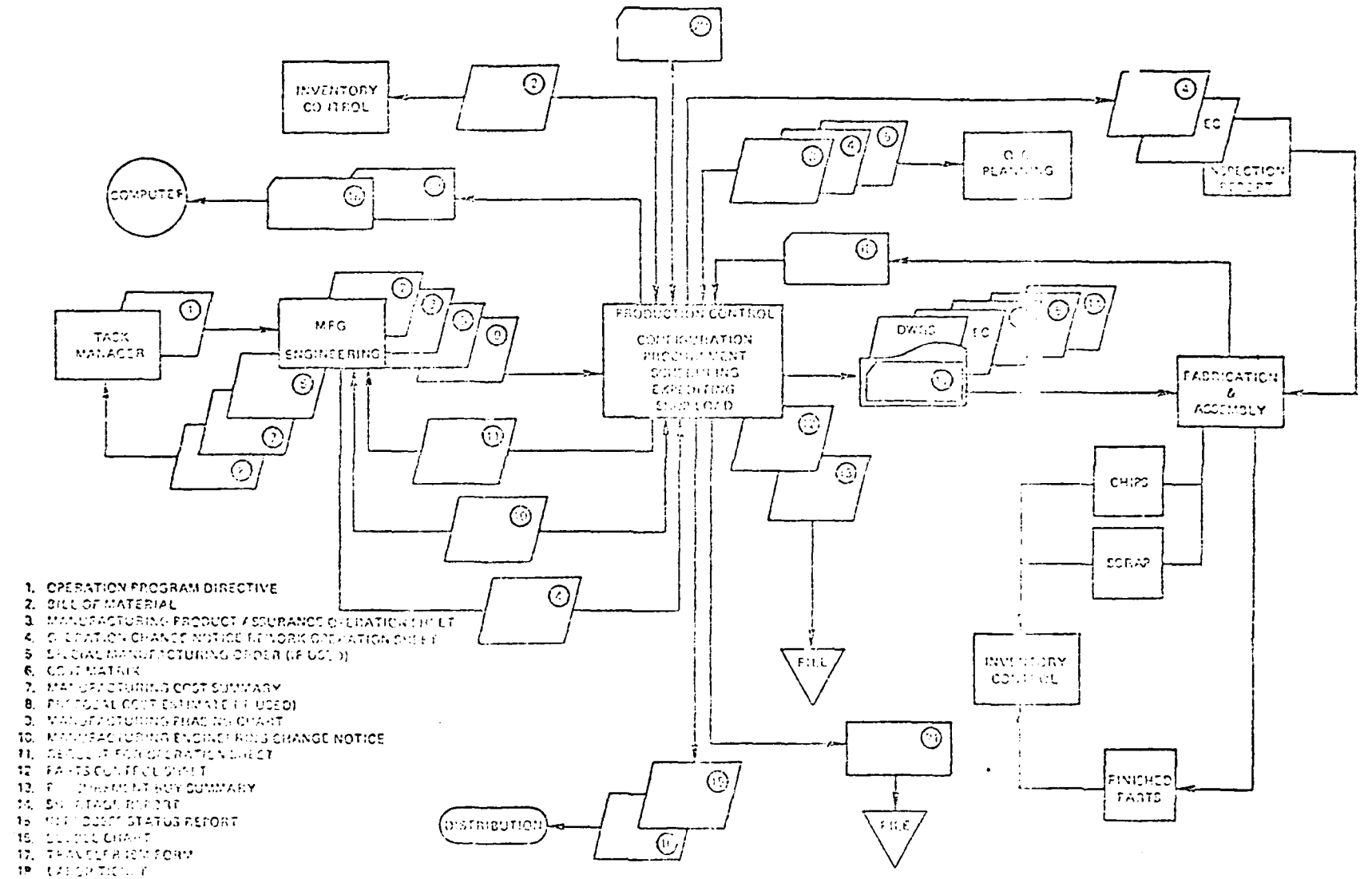


Figure 2.1-3 MANUFACTURING DOCUMENTATION FLOW

2.1 PRODUCTION MANAGEMENT (Cont'd)

Company policy and functional responsibilities are defined in the Avco Systems Division Policies and Procedures Manual. The specific procedures applicable to the MK 12A CCN program are:

Program Management	-	Policy #57
Subcontract Management	-	Section 5-20
Financial Management	-	Section 2-0
Quality Assurance	-	Policy #69
Configuration Management	-	Section 6-9
Scheduling and Data Management	-	Section 10-32
Failure Analysis Program	-	Section 9-1
Parts Control/Reliability	-	Section 9-16

All product components/subassemblies will be produced/procured by the Manufacturing Department. All manufacturing effort will be monitored and recorded by the Product Assurance Department. Table 2 provides the Critical Item Control Task matrix required by Item 1 of the Data Item Description. Although only the finished nosetip is considered a critical item, Table 2 shows (for information purposes) the controlling documentation and responsibility for each task involved in the production of a Carbon/Carbon Nosetip, P/N 7731107-1.

2.2 FABRICATION CONTROL

All fabrication and assembly operations of Avco/SD are performed to configuration control drawings, specifications and Manufacturing/Product Assurance Operations Sheets (M/PAOS). The M/PAOS are the mechanism for converting the

Table 2: CRITICAL ITEM TASK CROSS-INDEX (Ref. Item 1; DI-R-30511)

(SUB ASSEMBLY)

Critical Item Control Task	Responsible Organization	Support Organization	Title	Number	Date	Applicable Portion
MACHINED CONSTRUCTURE (SHELL)						
Manufacture	Avco/SD Manufacturing Dept.	Avco/SD Product Assurance Department	Shell, Nose; Forward Section M/PAOS*	7731108	CURRENT ISSUE/REVISION	(Drawing)
			Fluorescent Penetrant Inspection	QATP 30556		
Unbonded Surface Preparation	"	"	Coatings, Chemical Conversion; Aluminum & Al Alloys	MIL-C-5541, Class 3		
Bonding Surface Preparation	"	"	Bonding Thermal Shields w/HA 934 Adhesive	240-02-0004-E		
			Primer Thickness Test	QATP 30548		
Retainer, Disc	"	"	Retainer Ring	7731113		(Drawing)
3-D CARBON/PHENOLIC COLLAR						
Manufacture Billet[1]	Haveg Industries	"	Billet Carbon Phenolic PAOS*	7731111		(Drawing)
			Planning Procedure, Nose Shield	HP5285 (Haveg)		Operations 10 thru [illegible]
			Thermal Shields, Carbon Phenolic; RV 12 Reentry Vehicles	240-330-21-0011-1		
			Billet Tensile Properties	QATP 30559		
Machining	"	"	Shield, Nose PAOS*	7731109		(Drawing)
			Planning Procedure, Nose Shield	HP 5285 (Haveg)		Operations 90 thru [illegible]
RESIN-IMPREGNATED 3-D CARBON[2] NOSE						
Yarn, Inspection of	Hercules, Inc.	None	Yarn, Graphite; 1000/3000 Filaments PAOS*	MIL-Y-87125		
Fabric, Inspection of	Textile Products, Inc.	Avco/SD Product Assurance Department	Fabric, Graphite Fiber M/PAOS*	MIL-F-87121		
Rods, Fabrication & Inspection[1]	Avco/SD Manufacturing Dept.	"	Rod, Pultruded, Graphite Fiber Reinforced M/PAOS*	MIL-R-87120		
Preforms, Fabrication & Insp.[1]	"	"	Preform, Rigidized of Graphite Fibers	MIL-P-87122		
			Preform M/PAOS*	7731112-5		(Drawing)
Rigidization[1]	"	"	Preform, Rigidized; Graphite	MIL-P-87123		
			Preform, Rigidized M/PAOS*	7731112-3		(Drawing)
			Phenolic Coal Tar	MIL-P-87124		
			X-Ray	MIL-STD-453		
			Density Measurement	MIL-STD-452		
			Dimensional Inspection Gaging	[illegible]		

[1]These tasks are considered critical.

M/PAOS = Manufacturing/Product Assurance Operations Sheet. Annexes part/specification number.
QATP = Quality Assurance Test Procedure

Table 2: CRITICAL ITEM CONTROL TASK CROSS-INDEX (Cont'd)

(SUB ASSEMBLY)

Critical Item Control Task	Responsible Organization	Support Organization	CONTRACTOR POLICIES & PROCEDURES: Title	Number	Date	Applicable Portion
RVBM-USE [illegible] 3-D CARBON[2] NOSE						
Densification[1]	General Electric Co., RESD	Avco/SD Product Assurance Department	Mk 12A Preform Densification Control Document	G.E. Mk12A-1000	CURRENT ISSUE REVISION	All
			Billet, Densified	7731112-1		(Drawing)
			M/PAOS* - [illegible]			
			Preform, Densified; Hi-pressure Pitch-Based, Graphite Fiber, 3-D Fine Weave	[illegible]-P-87119		All
			Mat'l Spec for 3-D Carbon/Carbon Billet	[illegible]-1104		
			Billet Tensile Properties	QATP 20551		
			Billet Compression Properties	QATP 20552		
			Billet Torsional Shear Properties	QATP 20553		
			Billet Thermal Conductance	QATP 20556		
			Billet Density	QATP 20557		
			Nosetip	[illegible]-1110		(Drawing)
			M/PAOS*			
NOSETIP, MACHINED; FWD SECTION						
Bonding[1]	Avco/SD Manufacturing Dept.	"	Nosetip Assembly, Forward Section	7731114		(Drawing)
			M/PAOS*			
			Bonding Thermal Shields with EA934 Adhesive	[illegible]-60-02-0004-E		
			Fixture	[illegible] 26125, Rev. A		(Drawing)
Final Machining & Inspection	"	"	Nosetip, Machined; Forward Section	[illegible]-1107		(Drawing)
			M/PAOS*			
			General Weighing Procedure	QATP 20556		
			Visual Examination	QATP 20559		
			X-Ray	QATP 20565		
			Examination of Product	QATP 20566		
			Materials & Processes for Corrosion Prevention & Control in Aerospace Weapons Systems	MIL-STD-1568		Paragraph 5.4.4.2
			Lubrication, Solid Film, Air Drying	MIL-L-23398		

[1] These tasks are considered critical.

*M/PAOS = Manufacturing/Product Assurance Operations Sheet. Annexes part/specification number.
QATP = Quality Assurance Test Procedure.

2.2 FABRICATION CONTROL (Cont'd)

drawing and specification requirements into the form used by the individual, machine operator, assembler and/or inspector. These sheets, written by the Manufacturing and Product Assurance departments, are a detailed step-by-step set of instructions which tell the technician.

a) what to do (operating instructions),

b) when to do it (sequence of operations),

c) where to do it (department and facility to be used), and

d) what to use (tooling/material requirements).

M/PAOS assure that proper inspection operations are performed in sequence and that all drawing and specification characteristics are inspected prior to the acceptance of the part. Each operator and/or inspector assigned to do a specific task has all the required information and is not required to research blueprints and/or specifications for his portion of the total requirement. The possibility of interpretational errors is eliminated and each part is produced and inspected in the same manner every time.

In-process quality verification includes continual gaging by the operator, and quality monitoring by a roving inspector. The first piece produced on each shop production order is subjected to "first piece inspection" by the Quality Control department. Each component and subassembly is assigned a serial number, its configuration identified and a record maintained as each order is processed.

Required changes in parts and assemblies are documented by the Design Engineering Group through Avco Engineering Changes (E.C.). The Manufacturing Engineering Group transfers this information to an Operation Change Notice-Rework Operation Sheet for use in manufacturing.

2.2 FABRICATION CONTROL (Cont'd)

Close coordination with the Quality Assurance Group is maintained by issuance of Configuration Record Cards by the Production Control Group. This document records how an item is inspected and stored or shipped. Any hardware discrepancies from the manufacturing documentation is noted by Quality Assurance. Disposition of discrepancies is made by the cognizant design engineer with the approval of the Program Office.

2.3 CONFIGURATION CONTROL

The organization and orderly flow of Avco's longstanding Configuration Control System assures complete overview and control of the Nosetip design baseline. Specific CCNT configuration management direction is imposed on the line departments by the Program Manager through project directives prepared and released in accordance with AVCO/SD Policy and Procedure 10-5.

The Configuration Manager, with delegated authority to act for the program manager, is SAMSO's single point of contact for all matters concerning configuration management. He is responsible for monitoring all line departments for compliance with the configuration management requirements of the program and provides detailed program direction for implementing this task. He has final approval authority with regard to the necessity, effectivity, and classification for all Avco proposed changes. No change is released or submitted to SAMSO without the signature approval of the Configuration Manager. Changes to released documentation are implemented by an Engineering Change (EC) or Specification Change Notice (SCN). These are coordinated, signed-off and released in the same manner as are drawings and specifications.

2.3 CONFIGURATION CONTROL (Cont'd)

Step-by-step details of this procedure are specified in Avco's "Engineering Documentation Handbook". After the Nosetip specification is approved by BMO, any change will require BMO's approval prior to implementation.

Avco imposes the same configuration control requirements described above on all subcontracts.

2.3.1 Detailed Response to Item 4, DI-R-30511 - Critical Item Control During and After Manufacture.

Date Coding

Not applicable. Quality Assurance Configuration Record Cards will show the dates of every in-process and final inspection of each nosetip assembly.

Traceability

A Quality Assurance control number will be assigned each component of the nosetip assembly for identification purposes through fabrication. An Air Force 7-digit serial number will be assigned each completed end-item.

2.3 CONFIGURATION CONTROL (Cont'd)

Assembly Techniques

Avco is uniquely qualified to produce the Mark 12A Carbon/Carbon Nosetip. We were the first to develop and apply carbon/carbon materials to reentry vehicle nosetips and are also the developers of the Fine Weave Pierced Fabric billets for high temperature applications.

Sophisticated equipment such as the Fabric Piercer and Nosetip Bonding Fixture automate these painstaking processes and eliminate skilled-operator techniques.

Manufacturing/Product Assurance Operation Sheets detail every manufacturing and inspection task for each component/assembly.

Extended Acceptance Test Requirements

The Detailed Equipment Test Plan - NDE and Destructuve Test Plan, Avco Document AVSD-0114-80-CR, 4 April 1980 details all levels of MK 12A CCNT end-item and process equipment testing and acceptance.

Subcontractor/Manufacturer Controls

Both subcontractors/manufacturers on the Mark 12A CCNT program have been qualified by their work on previous aerospace programs. Their detailed manufacturing process documents have been reviewed and approved by Avco's Manufacturing and Product Assurance department engineers. Both G.E. and Haveg, Inc., will provide Avco with manufacturing history software for each lot shipped.

2.3 CONFIGURATION CONTROL (Cont'd)

In-process Controls

M/PAOS provide mandatory inspections throughout the fabrication processes. Figure 2.3-1 shows in-process inspection with respect to the related manufacturing tasks.

Special Handling

Controlled by M/PAOS. White-glove handling specified for carbon/carbon components to minimize human acids/salts contamination.

A special plywood shipping container designed to MIL-P-9024 with interchangeable foam plastic inserts will be used to transport/store the rigidized preforms, densified billets and finished nosetips.

Storage Requirements

See above. All metal parts are protected with corrosion preventive materials/processes. Finished, accepted end-items will be placed in heat-sealed plastic bags and packed into conformal cavities (5) of shipping container foam-plastic insert.

2.4 QUALITY ASSURANCE MANAGEMENT

Avco's existing Quality System has been developed in accordance with SAMSO STD-73-5B, MIL-Q-9858A, MIL-C-45662, MIL-STD-1520 and MIL-I-6870.

The Avco Quality System is constantly monitored by the resident DCAS. In addition, periodic reviews are performed by various contracting agencies. The most recent review was the Selected Products Quality Review (SPQR) in October of 1976. The results of this review confirmed that Avco's Quality

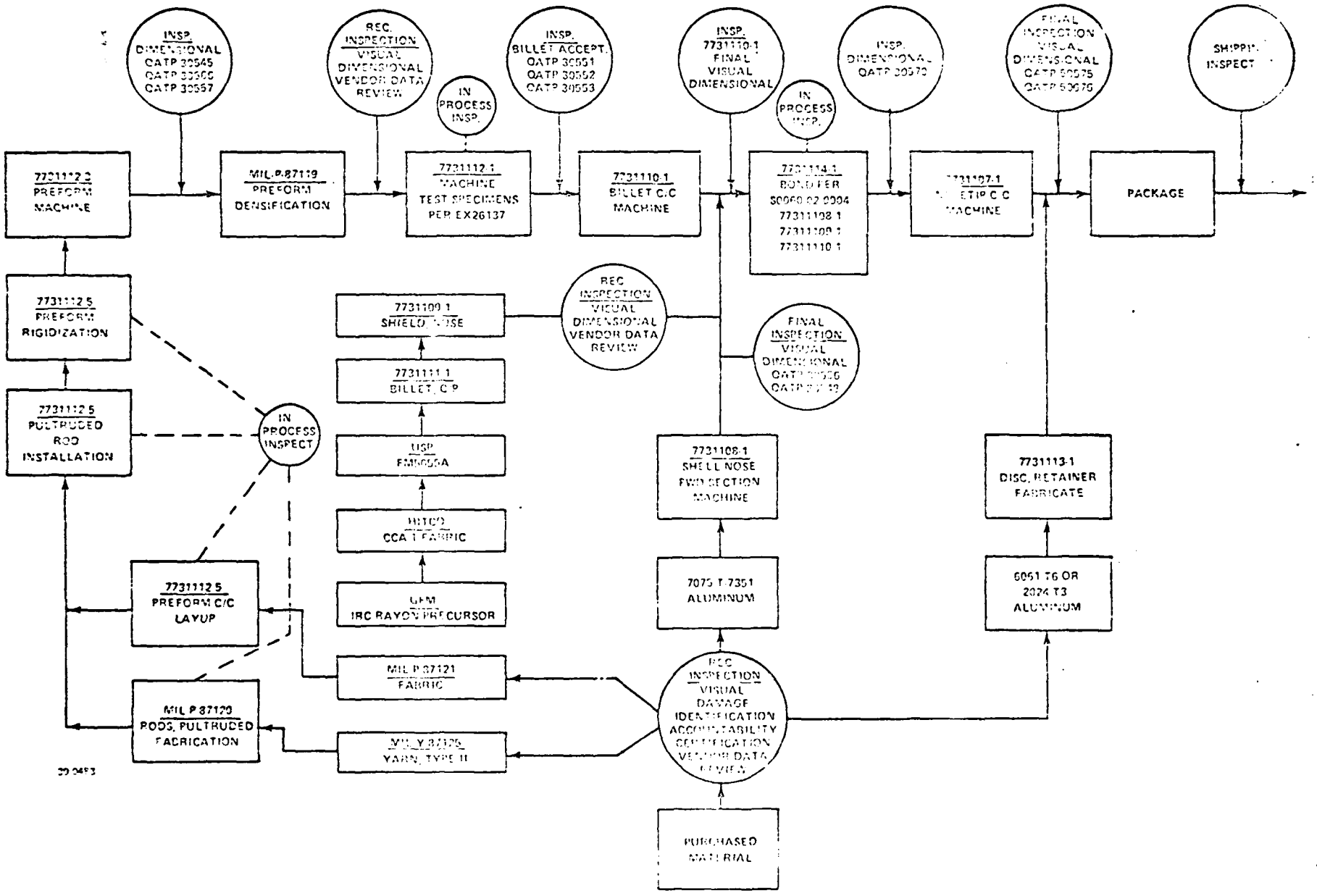


FIGURE 2.3-1. FLOW DIAGRAM FOR NOSETIP ASSEMBLY PRODUCTION CYCLE

Assurance procedures were implemented to ensure product performance in accordance with contract requirements. Successful programs such as Minuteman Mark 11, RVTO, ABC, PAVE PEPPER, PTP, RSLP and recently, TDT and T-REP are further evidence of the competency and excellence of Avco's Product Assurance Department and Quality System.

The Avco Product Assurance Department has the responsibility and authority to assure company management and its customers that all Avco products are in accordance with or exceed contractual quality requirements.

Figures 2.4-1 and 2.4-2 are flow charts depicting material flow for purchased items and Avco manufactured items respectively. Figure 2.4-3 is the Inspection and Process Flow Chart for the Mark 12A CCNT and lists the controlling operations sheets and Quality Assurance Test Procedures (QATP) applicable to each component/subassembly.

2.4.1 Program Engineer

The primary responsibility for the implementation of Product Assurance for the Mark 12A Nosetip Program rests with the Program Engineer, Mr. Robert Call. He has the delegated authority to direct and coordinate all of the elements defined in the body of this plan. He will maintain a communications network between the Program Manager and cognizant elements within the Avco organization, as well as provide an effective quality cost management program.

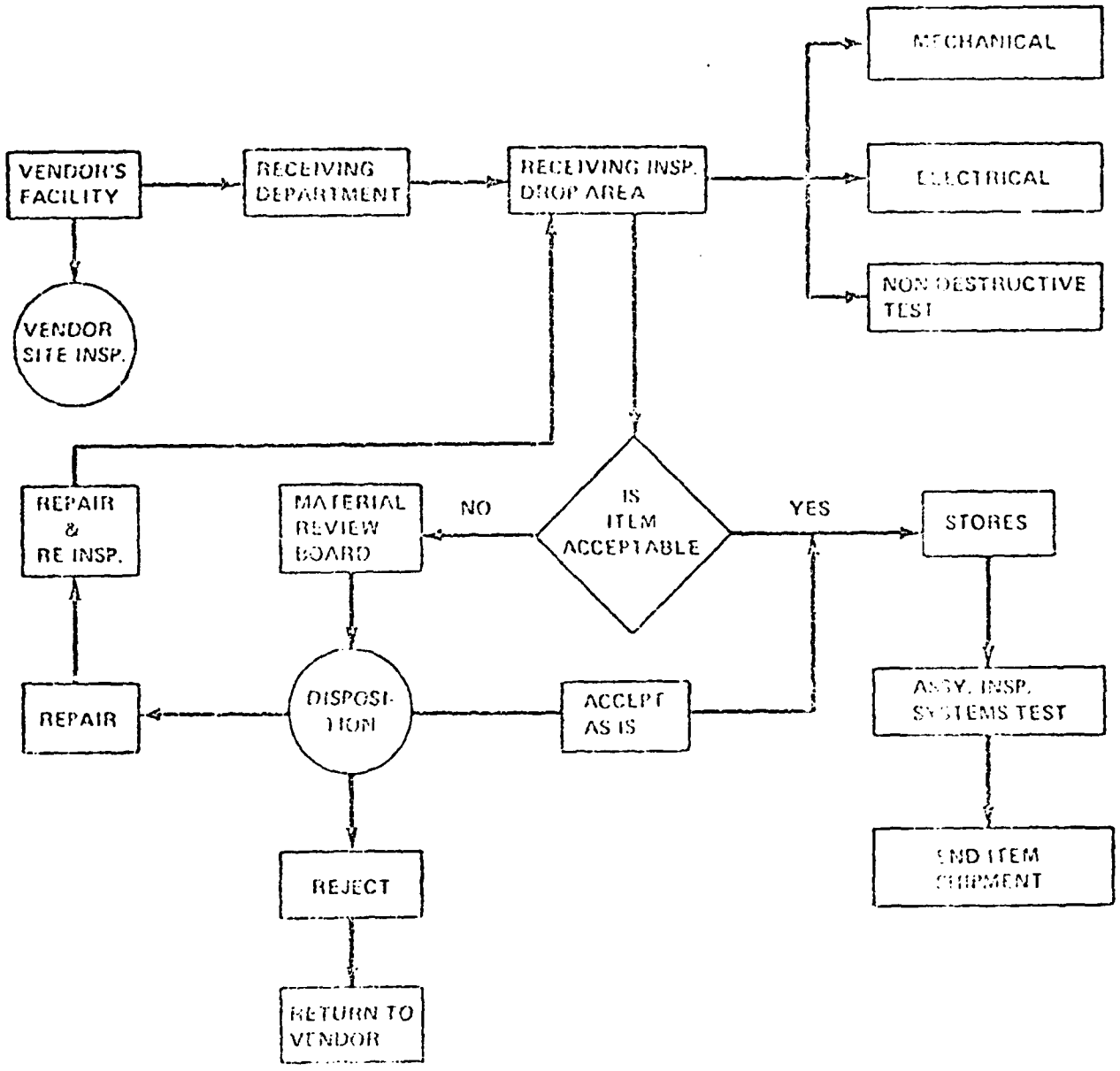


FIGURE 2.4-1. PRODUCT ASSURANCE MATERIAL FLOW CHART - PURCHASED ITEMS

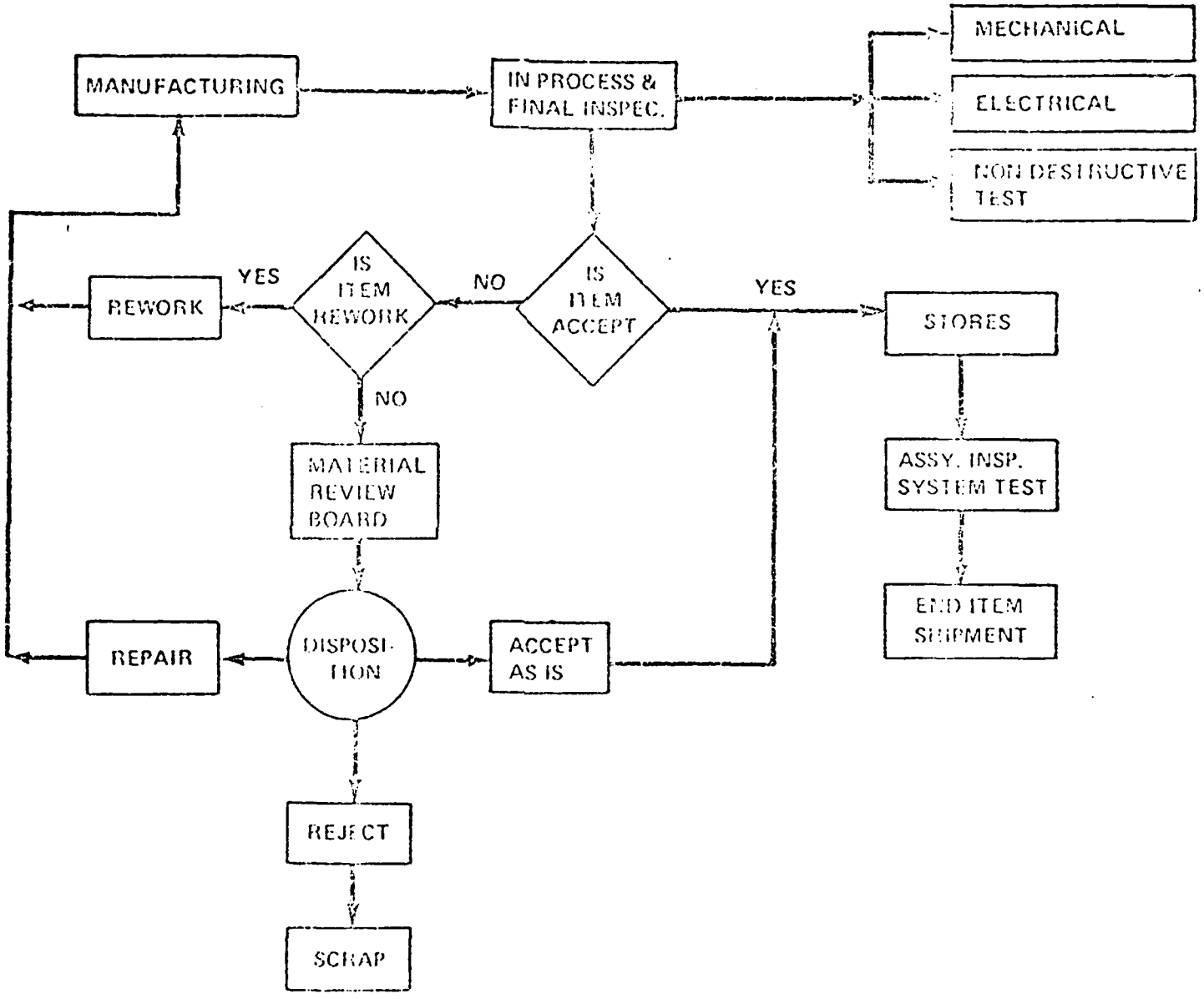
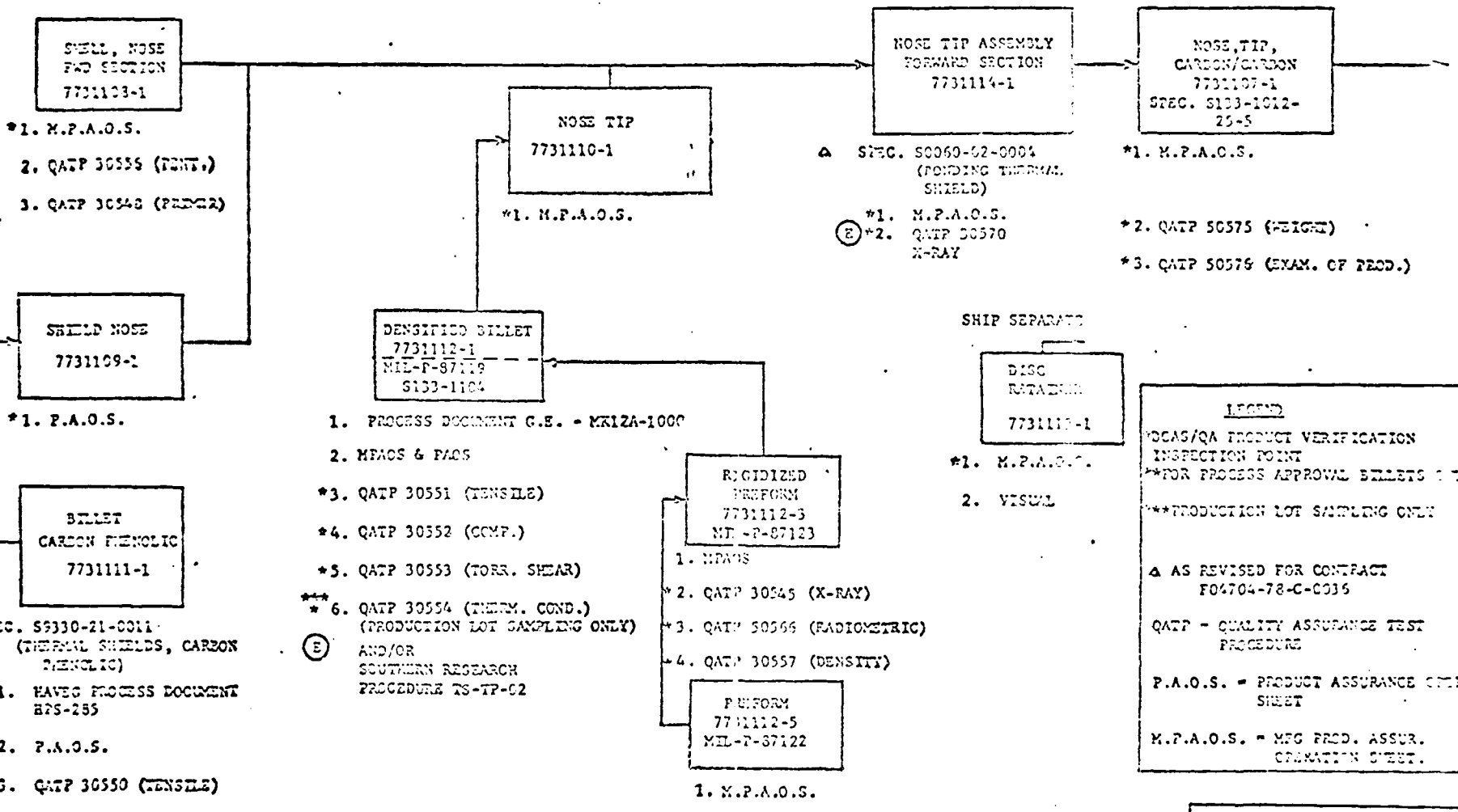


FIGURE 2.4-2. PRODUCT ASSURANCE MATERIAL FLOW CHART - AVCO MANUFACTURED ITEMS

PRODUCT ASSURANCE
INSPECTION AND PROCESS FLOW CHART
NOSE TIP
CARBON/CARBON
7731107-1
SPEC. S133-1012-25-5
(MK 12A)



LEGEND

(S) DCAS/QA PRODUCT VERIFICATION INSPECTION POINT

**FOR PROCESS APPROVAL BILLETS ONLY

***PRODUCTION LOT SAMPLING ONLY

Δ AS REVISED FOR CONTRACT F04704-78-C-0036

QATP - QUALITY ASSURANCE TEST PROCEDURE

P.A.O.S. - PRODUCT ASSURANCE OPERATION SHEET

M.P.A.O.S. - MFG PROD. ASSUR. OPERATION SHEET.

PROJECT ENG'R R E [illegible]

WRITER [illegible]

REV. E

DATE 11-27-79

3.0 PRODUCT FABRICATION

This section provides a brief description of the fabrication and processing methods to be used by Avco for production of the 3-D Carbon/Carbon nosetips for Mark 12A reentry vehicles.

Avco is uniquely qualified to perform the production for this Mark 12A nosetip program. We were the first to develop and apply carbon-carbon materials to reentry vehicle nosetips and have remained continuously active in this area of materials and fabrication technology.

3.1 FWPF CARBON/CARBON BILLET FABRICATION (Reference Figure 3.1-1)

Seven-inch squares of Graphite Fiber Fabric are loaded into the semi-automatic piercing fixture where they are pierced by steel rods and compacted until a specified height of stack is reached. The resulting compacted stack (with steel rods in place) is then transferred to a restraining device where the steel rods are removed one-by-one and replaced by Graphite Fiber Rods. Manufacturing/Product Assurance Operations Sheets (M/PAOS) detail each step and associated inspection.

The graphite yarn used to manufacture the woven fabric (1000-filament yarn) and the pultruded rods (3000-filament yarn) is produced in accordance with specification MIL-Y-87125 - Yarn, Graphite, 1000/3000 Filaments. The fabric is produced in accordance with specification MIL-P-87121 - Fabric, Graphite Fiber. The rods are manufactured in accordance with specification MIL-R-87120; Rods, Pultruded, Graphite Fiber, Reinforced Processing Of. Each lot of the above items produced is subjected to acceptance testing as required by the specifications.

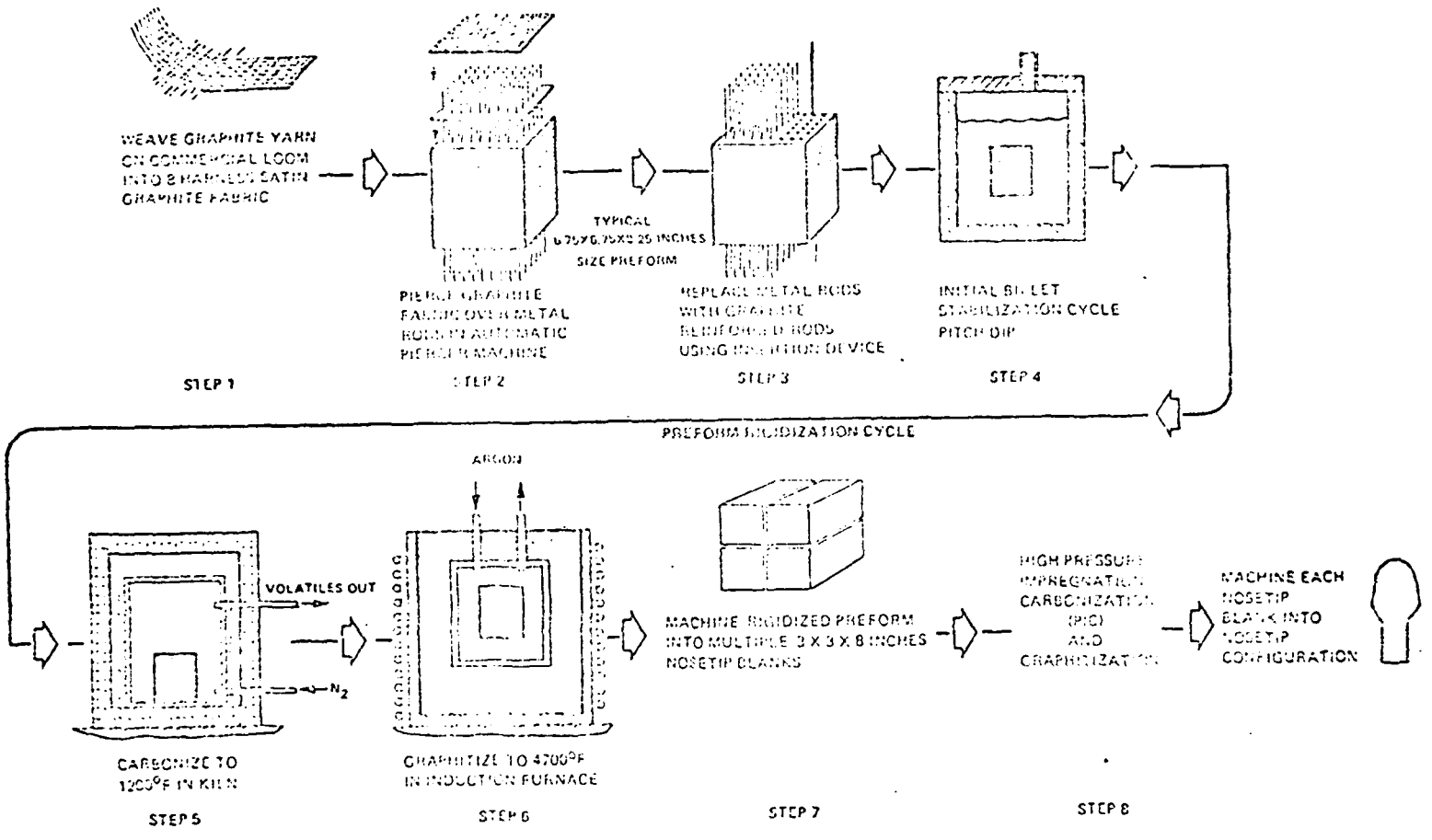


Figure 3.1-1 FLOW DIAGRAM - FWPF CARBON/CARBON NOSETIP FABRICATION

3.0 PRODUCT FABRICATION (Cont'd)

3.1 FWPF CARBON/CARBON BILLET FABRICATION (Reference Figure 3.1-1) (Cont'd)

When all the steel rods have been replaced by graphite rods, the preform is submerged in coal-tar pitch at 500°F. After a specified time, it is removed and drained, placed into a carbonizing kiln and heat-treated to 1200°F in an inert atmosphere. It is then transferred to an induction furnace and graphitized at 4700°F.

The coal-tar pitch used in the rigidization process is procured and inspected to MIL-P-87124 - Pitch, Coal-tar. The method complies with MIL-P-87122; Preform, Rigidized of Graphite Fiber; 3-D Fine-Weave Pierced Fabric, Processing of.

After cooling, the rigidized preform is machined into four nosetip preforms to be inspected for conformance with MIL-P-87123. Tests include radioactive gaging for density gradient, radiographic inspection for missing yarns. x, y and z spacing, voids and/or high density inclusions.

3.2 PREFORM DENSIFICATION

The rigidized preforms are then shipped to General Electric Company/Reentry Systems Division, Philadelphia, PA for densification in accordance with MIL-P-87119; Preform Densification, High Pressure, Rigidized Graphite Fiber, 3-D Fine-Weave Orthogonal, Processing Of. Basically, this process consists of a high pressure impregnation-carbonization (HiPIC) and a subsequent graphitization. Coal-tar pitch (MIL-P-87124) is used as the matrix precursor. This process yields the carbon-carbon billets which comply with specification S-133-1104 - Material Specification for Three-Dimensional Carbon/Carbon Billet, and drawing 7731112 - Billet, Carbon/Carbon.

3.2 PREFORM DENSIFICATION (Cont'd)

GE's detailed densification process description (SK12A-1000), and their quality assurance plan, have been approved by Avco. Process certification tests per MIL-P-87119 will be performed by GE, and witnessed by Avco. Characterization tests per that specification conducted by Avco will be used to complete the determination of process adequacy. Since precise control of temperature and pressure during HiPIC are critical, certification will be provided by GE that the instrumentation is calibrated to specification MIL-C-45662. Acceptance tests on the individual production items are done partly at GE; the remaining tests, requiring special equipment, are performed at Avco. Avco will implement on-site surveillance at GE for the first several months of billet production. Subsequently, GE will submit copies of the billet densification history data for all production cycles.

On receipt at Avco/SD, the densified billets will be subjected to Quality Assurance and production control procedures and then rough-machined to the configuration of drawing 7731110. The billets are then stored until required for bonding and final machining.

3.3 2-D CARBON-PHENOLIC NOSE SHIELD

The carbon-phenolic collar, fabricated from filled, phenolic resin-impregnated carbon fabrics, is procured from a qualified subcontractor in the machined-to-configuration condition, and is in compliance with the requirements of specification S-9330-21-0011-1; Thermal Shields, Carbon-Phenolic, For the Mark 12A Reentry Vehicle; 5 December 1978. The billet from which the collar is machined is per drawing 7731111; Billet, Carbon-Phenolic.

In-process and production item quality assurance testing, and production control processing are as shown in Figure 2.4-3. Avco will implement periodic on-site

quality assurance inspections. The machined 2-D carbon phenolic collar, illustrated in Figure 3.3-1, is per drawing 7731109 - Shield, Nose.

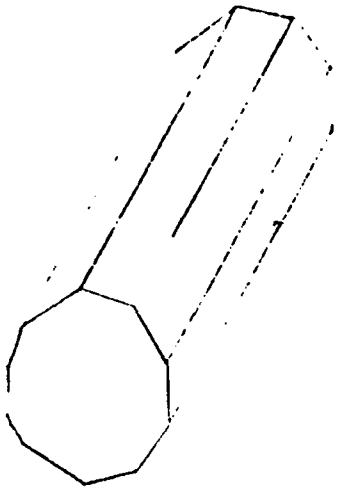
3.4 MACHINED SUBSTRUCTURE

The substructure is machined from a 7075-T73 aluminum billet, and conforms to drawing 7731108 - Shell, Nose, Forward Section. The retainer disc used with the nosetip assembly is stamped from 6061-T6 or 2024-T3/T4 aluminum, and is in accordance with drawing 7731113 - Disc., Retainer.

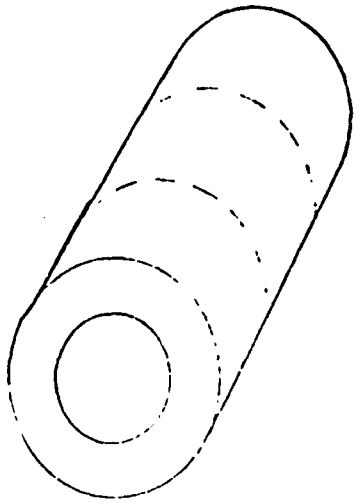
3.5 ASSEMBLY & BONDING OF MACHINED COMPONENTS

Manufacturing will draw from the storage area only components that have been inspected and approved by the Quality Control Section. Components will be kitted into convenient lot sizes to represent the number that is scheduled for bonding in the assembly area. When all records and paperwork have been verified by Quality Control, the bonding operations will proceed.

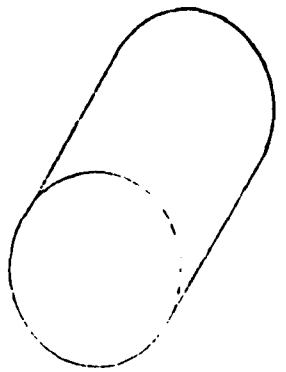
The criticality of bond uniformity and bondline tolerances, and of the concentricity of the nosetip with respect to the collar and substructure, necessitate the validation of the bonding fixture to verify the tooling concept, and the qualification of the bonding process and the operators. A stainless steel mockup of the nosetip components will be used to verify the quality of the assembled nosetip as controlled by the fixture. A lucite model of the nosetip will be used to assure that the bonding material is distributed uniformly over all of the mating surfaces. Following validation, the bonding fixture will permit semi-skilled operators to produce first-quality assemblies.



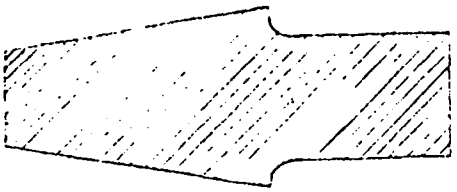
3-D CARBON/CARBON BILLET
P/N 7731112



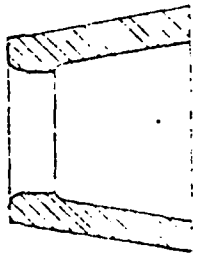
2-D CARBON/PHENOLIC
BILLET. P/N 7731111



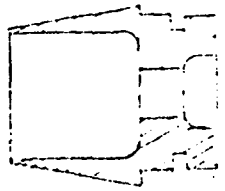
7075-T73
ALUMINUM BILLET



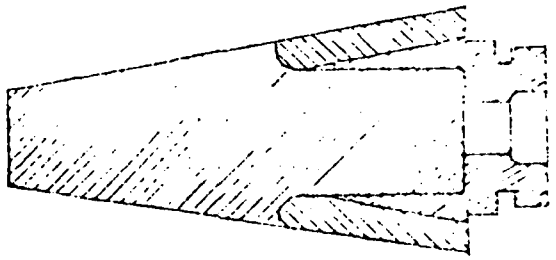
ROUGH-MACHINED
3-D C/C NOSETIP
P/N 7731110



NOSE SHIELD
P/N 7731109

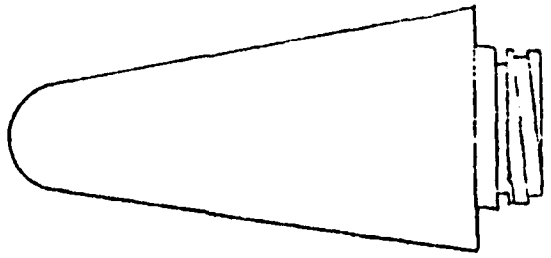


NOSE SHELL
P/N 7731108



BONDED NOSETIP ASS'Y

P/N 7731114



FINISH-MACHINED
CARBON/CARBON NOSETIP

P/N 7731107

Figure 3.3-1 NOSETIP ASSEMBLY

3.5 ASSEMBLY & BONDING OF MACHINED COMPONENTS (Cont'd)

The three components will be pre-fitted in the bonding fixture. Following approval by Q.A. of the prefit, the assembly will be disassembled, adhesive applied to all mating surfaces and the units re-installed into the bonding fixture in the identical sequence as the prefit and clamping pressure applied. The completely secured and bonded assembly will be cured for one-hour at $200 \pm 10^{\circ}F$. Following cool-down, the bonded assembly will be removed from the fixture and the tooling recycled while the bonded assembly (P/N 7731114-1) becomes available for final machining.

All requirements pertaining to preparation of the surfaces for bonding, and for qualification of the EA934 adhesive, are contained in specification S0060-02-0004-E; Bonding Thermal Shields with EA934.

The non-bonded surfaces of the aluminum are chemical film treated per MIL-C-5541, Class 3 (except for the 0.500-20 UNF2B thread). The 2½-5 Acme thread is coated with solid film lubricant (0.0002-0.0005 inch) per MIL-L-23398, and meets Section 5.4.4.2 of MIL-STD-1568.

3.6 FINAL MACHINING OF NOSETIP ASSEMBLY

The bonded and cured assemblies, consisting of a carbon-carbon tip, carbon phenolic collar and aluminum structure which have satisfied all dimensional and test requirements will be routed to the machine shop for final machining. Contamination protection will be observed during all handling and machining operations.

3.6 FINAL MACHINING OF NOSETIP ASSEMBLY (Cont'd)

The tip will be installed into a threaded assembly fixture in the N/C lathe and the carbon/phenolic collar machined flush to the aluminum structure, and the tip will be contour-machined. Finally, the assembly will be cleaned, inspected, serialized, marked and stored in protective containers for shipment.

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